Rain Supplementary Video Captions

Supplementary Movie 1

Clip 1

A cluster of three sunflower pollen grains (d_p =35 μm each, θ =58°) impacts on a water droplet (U = 7.67 m/s) and is capture on the surface. Video was recorded at 100,000 frames per second (fps) and is played back at 10 fps.

Clip 2

A 53 μm particle of wood ash (θ < 10°) impacts a droplet (U = 4.44 m/s) and then gets pulled inside by surface tension. Video was recorded at 100,000 fps and is played back at 10 fps.

Clip 3

A particle of desert dust (d_p = 85 μm) impacts a droplet (U = 4.77 m/s) and creates a small cavity as it enters. Video was recorded at 100,000 fps and is played back at 10 fps.

Clip 4

A model particle (d_p = 82 μm, θ = 144°) impacts a droplet (U = 6.17 m/s) and creates a small cavity as it enters similar to the dust particle. Video was recorded at 100,000 fps and is played back at 10 fps.

Supplementary Movie 2

Clip 1

This particle experiences a surface capture (We_p = 6.47, R_i/R_d = 0.03, d_p = 82.5 μm, ρ_p=120 kg/ m^3, θ = 88°, and U = 6.86 m/s). Video was recorded at 100,000 fps and is played back at 10 fps.

Clip 2

This particle experiences a quasi-static seal entry (We_p = 77, R_i/R_d = 0.47, d_p = 196 μm, ρ_p=1070 kg/m^3, θ = 63°, and U = 5.18 m/s). As the particle enters the droplet the contact line is a little behind the equator and the water surface makes an angle close to 135° with the velocity vector. Hence, in the initial stage of entry the dynamic contact angle can be approximated as $\theta_d \approx 135°$ (used in Eq. 1 for hydrophilic particles) before the cavity starts to close behind the particle. Video was recorded at 90,000 fps and is played back at 10 fps.

Clip 3

The first particle to impact in this video experiences a shallow-seal entry and then it escapes out the back of the droplet (We_p =631, R_i/R_d=0.38, d_p = 82 μm, ρ_p=2500 kg/m^3, and θ =30°, and U = 14.89 m/s). The second particle to impact in this video enters and exits without a cavity seal and is the single enter exit case shown for hydrophilic particles in Fig. 2i of the main text (black x

symbol, We_p =1195, R_i/R_d=0.28, d_p = 82 μm, ρ_p=2500 kg/m^3, and θ =30^o, and U = 20.49 m/s). Video was recorded at 150,000 fps and is played back at 10 fps.

Supplementary Movie 3

Clip 1

This particle experiences a surface-seal entry and escape (We_p =1136, R_i/R_d =0.16, d_p = 82 μm, ρ_p = 2500 kg/m^3, θ = 30^o, and U=19.98 m/s). Video was recorded at fps and is played back at 10 fps.

Clip 2

This particle experiences a surface skid (We_p =14, R_i/R_d = 0.92, d_p=82 μm, ρ_p =2500 kg/m^3, θ = 30^o, and U = 2.23 m/s). Video was recorded at 90,000 fps and is played back at 10 fps.

Clip 3

This particle experiences a skid entry (We_p = 56, R_i/R_d = 0.82, d_p = 196 μm, ρ_p = 1070 kg/m^3, θ = 63^o, and U = 4.44 m/s). Video was recorded at 90,000 fps and is played back at 10 fps.

Supplementary Movie 4

Clip 1

This particle experiences a skid entry and escape (We_p =150, R_i/R_d = 0.91, d_p =196 μm, ρ_p = 1070 kg/m^3, θ =63^o, and U = 7.25 m/s). Video was recorded at 90,000 fps and is played back at 10 fps.

Clip 2

This particle experiences a surface skid and escape (We_p = 132, R_i/R_d = 0.99, d_p = 86.5 μm, ρ_p = 7800 kg/m^3, θ = 54^o, and U = 3.76 m/s). Video was recorded at 100,000 fps and is played back at 10 fps.

Supplementary Movie 5

Clip 1

This particle experiences a capillary pull in (We_p = 0.44, R_i/R_d = 0.84, d_p = 82.5 μm, ρ_p = 400 kg/ m^3, θ <10^o, and U = 0.98 m/s). Video was recorded at 100,000 fps and is played back at 10 fps.

Clip 2

This particle experiences a quasi-static seal entry, but because it is hydrophobic its dynamic contact angle is $\theta_d \approx 180^o$ (used in Eq. 1 for hydrophobic particles) with the contact line pinned near the equator (We_p = 70, R_i/R_d = 0.59, d_p = 196 μm, ρ_p=1070 kg/m^3, θ = 140^o, and U = 4.89 m/ s). This increases the resultant surface tension force on the particle. The ripple formed on the

droplet surface at impact distorts the view of the cavity making it appear that the cavity is bent toward the left near the particle. Video was recorded at 100,000 fps and is played back at 10 fps.

Supplementary Movie 6

Clip 1

This particle experiences a deep-seal entry ($We_p = 284$, $R_i/R_d = 0.12$, $d_p = 82$ μm, $\rho_p = 2500$ kg/m^3, $\theta = 144^o$, and $U = 9.98$ m/s). Video was recorded at 100,000 fps and is played back at 10 fps.

Clip 2

This particle enters and escapes without a seal ($We_p = 396$, $R_i/R_d = 0.13$, $d_p = 133$ μm, $\rho_p = 1070$ kg/m^3, $\theta = 158^o$, and $U = 14.29$ m/s). Video was recorded at 150,000 fps and is played back at 10 fps.

Supplementary Movie 7

Clip 1

This particle ricochets ($We_p = 42$, $R_i/R_d = 0.93$, $d_p = 133$ μm, $\rho_p = 1070$ kg/m^3, $\theta = 158^o$, and $U = 4.64$ m/s). Video was recorded at 100,000 fps and is played back at 10 fps.

Clip 2

This particle rebounds ($We_p = 29$, $R_i/R_d = 0.47$, $d_p = 133$ μm, $\rho_p = 1070$ kg/m^3, and $\theta = 158^o$, and $U = 3.85$ m/s). Video was recorded at 100,000 fps and is played back at 10 fps.

Supplementary Movie 8

Clip 1

A hydrophobic particle captured inside a droplet contacts the droplet interface and dewets, which causes surface tension to fling it out of the droplet. This phenomenon is know as resurrection. Video was recorded at 100,000 fps and is played back at 10 fps.

Clip 2

A hydrophobic particle captured inside the droplet has a bubble attached. The bubble contacts the droplet interface forming an unstable cavity that collapses forming a Worthington jet. As the cavity collapses the particle emerges onto the outer surface of the droplet. This is a partial resurrection. Video was recorded at 100,000 fps and is played back at 10 fps.

Supplementary Movie 9

Clip 1

A hydrophilic particle with $We_p = 30$ impacts another particle captured on the droplet surface at $R_i/R_d = 0.93$. The particle collision causes the impacting particle to ricochet away and the surface particle to enter. If the surface particle were not present the impacting particle should

have skid up the side of the droplet. Video was recorded at 90,000 fps and is played back at 10 fps.

Clip 2
A hydrophilic particle with $We_p = 40$ impacts another particle resting just inside the droplet surface at $R_i/R_d = 0.25$. The collision both wets the impacting particle and decelerates it such that surface tension holds the particle on the surface, but it no longer has enough inertia to enter with the expected quasi-static seal that should have occurred if the interior particle were not present. Video was recorded at 90,000 fps and is played back at 10 fps.